Service Systems, Natural Systems: Sciences in Synthesis

David Ing
President, International Society for the Systems Sciences
July 22, 2011, at Hull, UK

Agenda

1. Challenges
2. Service systems
3. Natural systems
4. Some frames
5. Learning and knowing
6. Call for participation

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1.1 Issues in the 21st century world

1.2 The heritage of the systems movement

1.3 A future for the systems movement

Issues in the 21st century world -- complex

WORLD ECONOMIC FORUM

http://www.weforum.org/videos/davos-2011-klaus-schwab

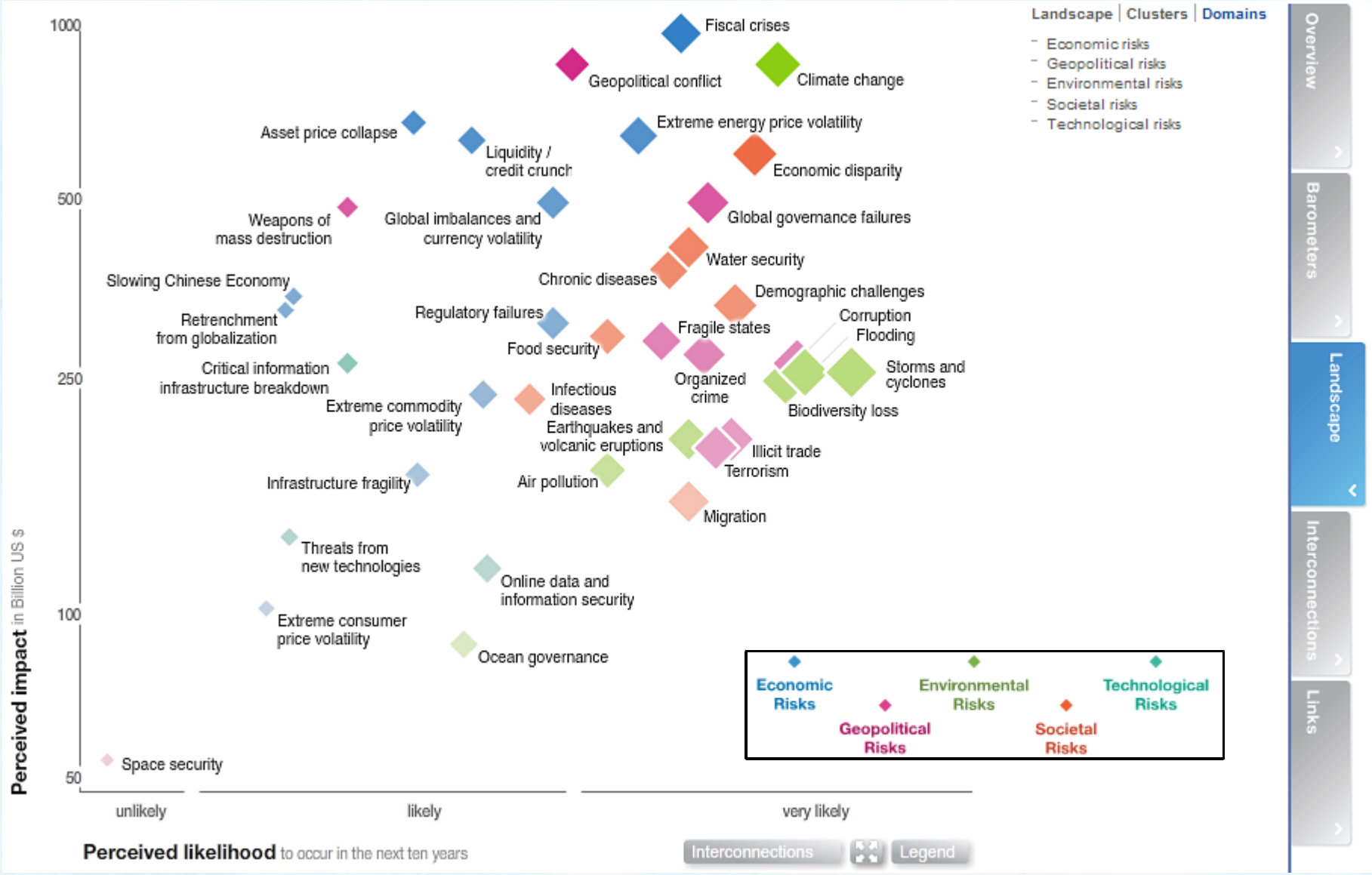
Home Issues Events Communities Reports

Davos 2011 - Klaus Schwab

Share

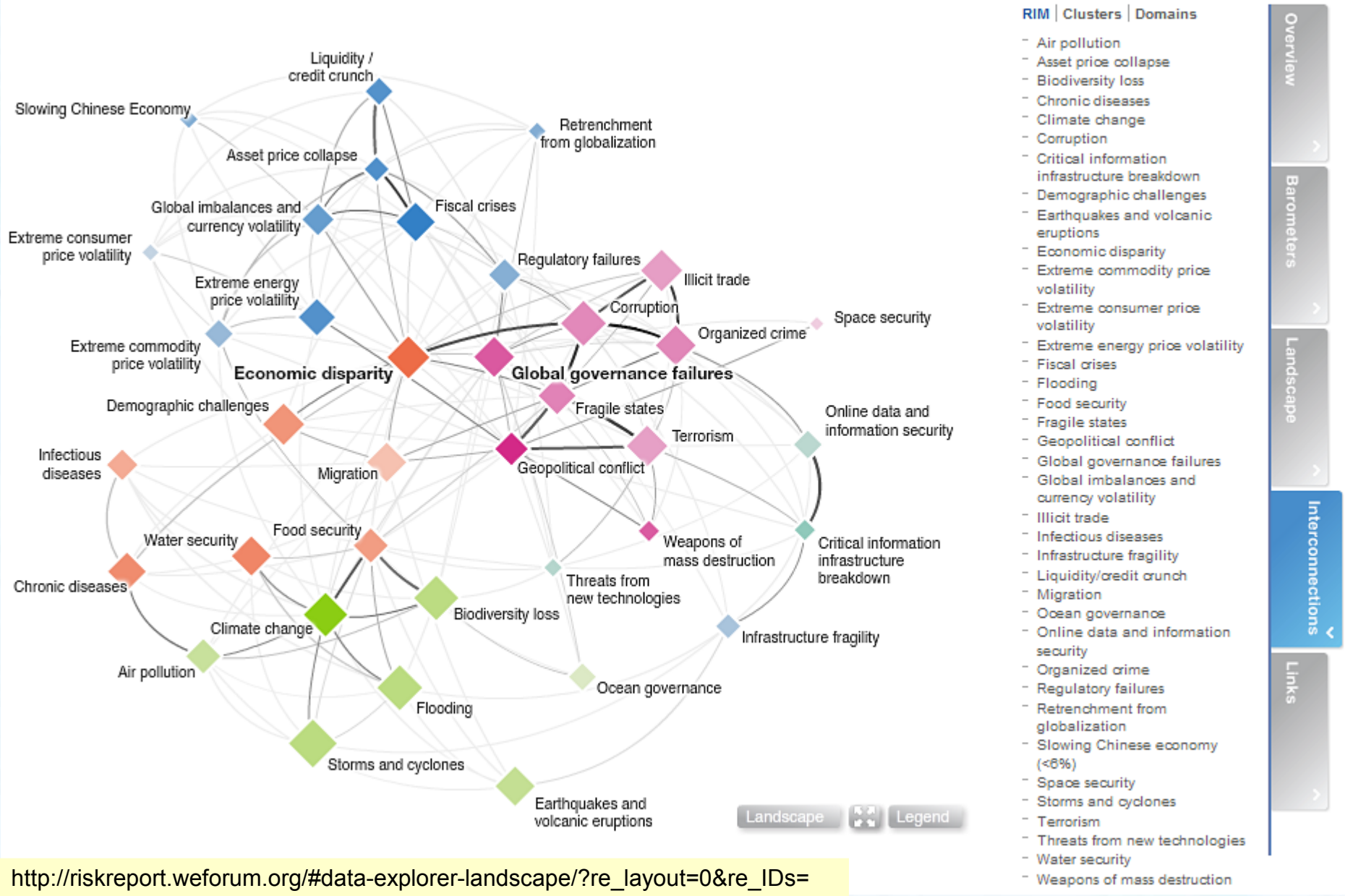
Klaus Schwab, Founder and Executive Chairman of the World Economic Forum, shares his objectives for the Annual Meeting 2011 which will take place in Davos-Klosters, Switzerland, from 26-30 January.

Landscape – Global Risks 2011 – WEF



http://riskreport.weforum.org/#data-explorer-landscape/?re_layout=1&re_IDs=

Interconnections – Global Risks 2011 – WEF



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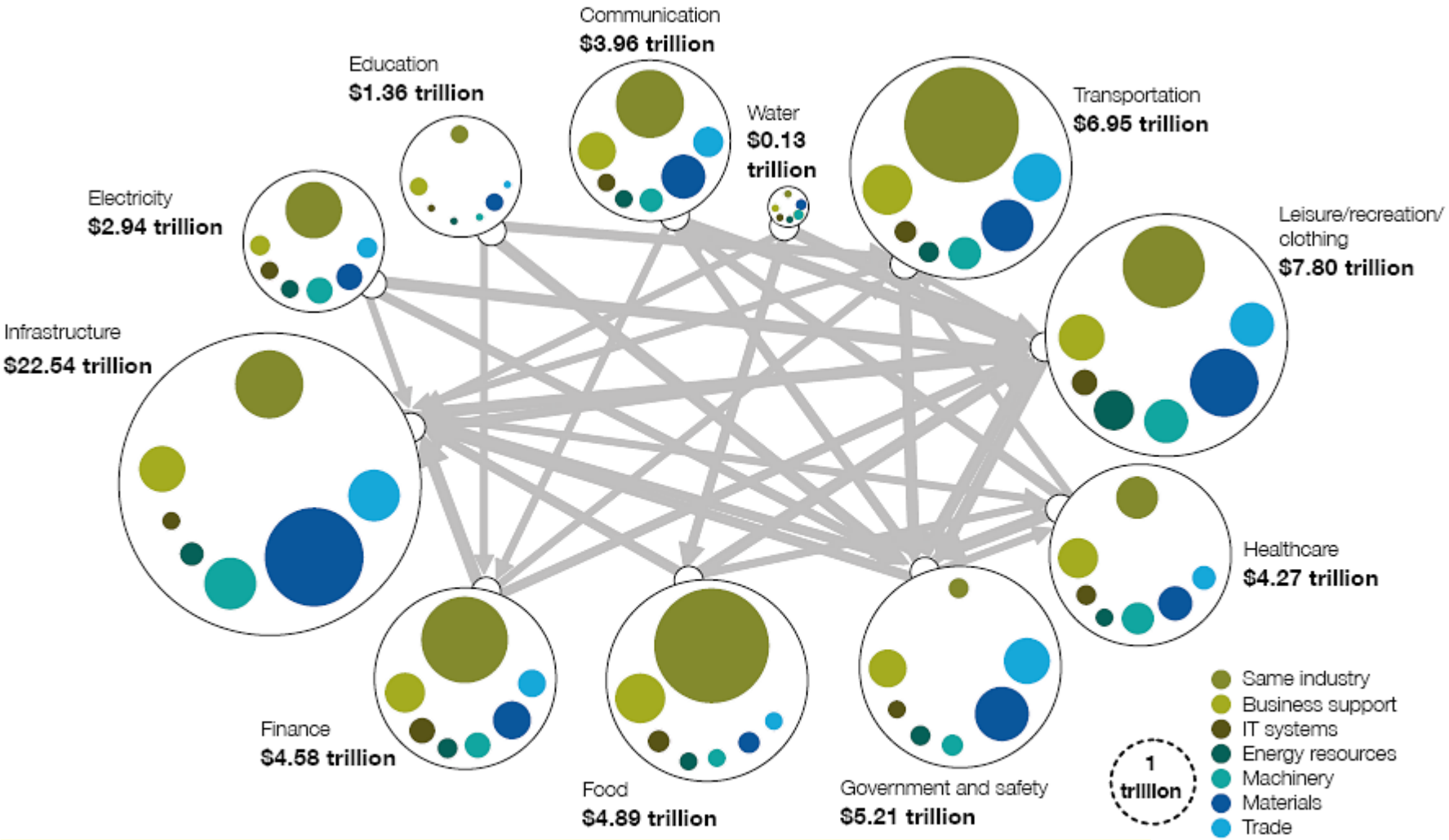
US$54 trillion system of systems -- IBM

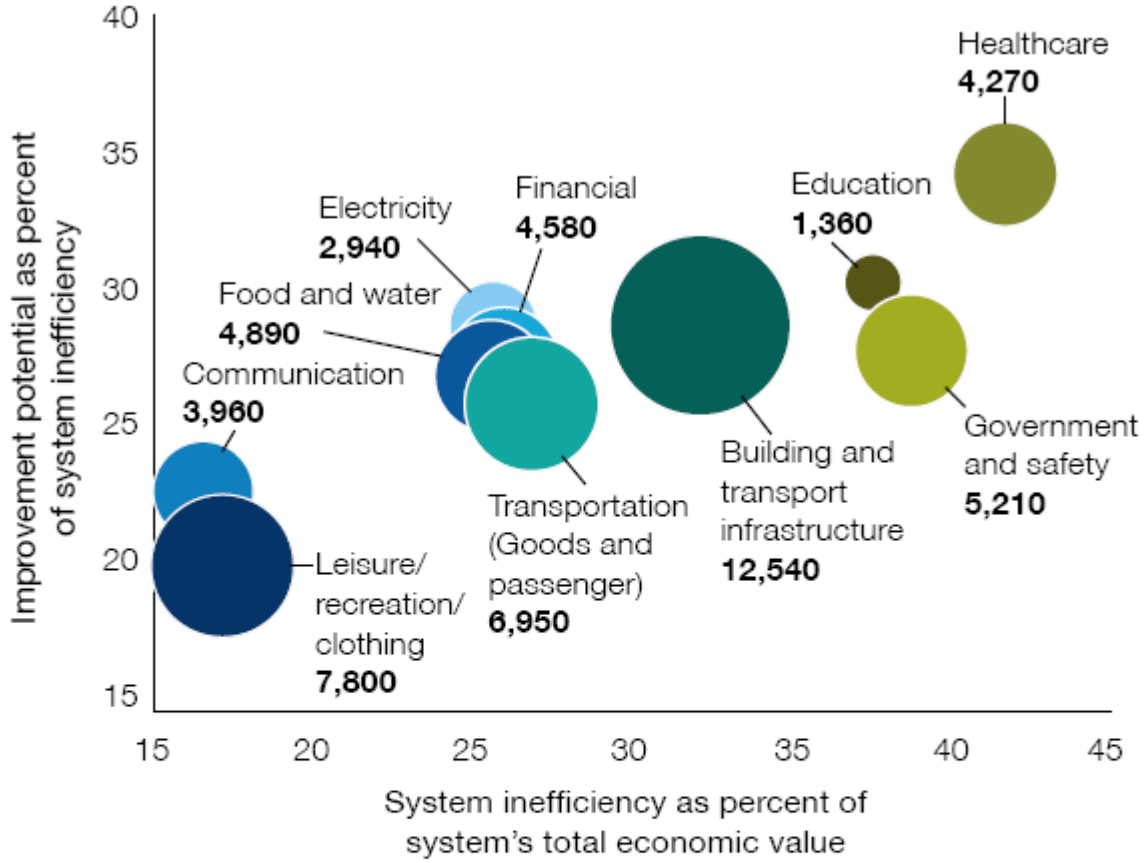


http://www-935.ibm.com/services/us/gbs/bus/html/ibv-smarter-planet-system-of-systems.html.

Note: Size of bubbles represents systems' economic values. Arrows represent the strength of systems' interaction.
Source: IBM Institute for Business Value analysis of Organisation for Economic Co-operation and Development (OECD) data.

Figure 1: We live and work within a complex, dynamic and interconnected US$54 trillion system of systems.

The world's $4 billion challenge -- IBM



Note: Size of the bubble indicates absolute value of the system in US$ billions
Source: IBM Institute for Business Value analysis based on inefficiency and improvement potential estimates reported during 2009 survey of 518 economists.

http://www-935.ibm.com/services/us/gbs/bus/html/ibv-smarter-planet-system-of-systems.html.

Figure 2: Of the US$15 trillion in inefficiencies within our global system, approximately US$4 trillion could be eliminated.

Heritage of the systems movement

1954:

- Bertalanffy, Boulding, Gerard and Rapoport
- mutual interest in theoretical frameworks
- systems
  - physical, technological, biological, social, symbolic
- interdisciplinary research
  - a general theory of complex systems

[Hammond 2003, p. 9]

Systems ... in many related perspectives

Systems thinking

An epistemology

- 1. emergence
- 2. hierarchy
- 3. communication
- 4. control

[Checkland 1981]

Synthesis precedes analysis

- 1. whole ... part
- 2. behavior ... containing whole
- 3. behavior ... role(s) or function(s) ... containing whole

[Ackoff 1981]

Systems engineering

attempts to

- shorten ... lags between scientific discoveries and their applications, and
- between ... human needs and the production of new systems ...
- in the space between research and business

[Hall 1965]

Systems practice

- implies a desire to find out how to use systems concepts in trying to solve problems.
- aimed at real-world problem-solving

[Checkland 1981]

Systems science

The objectives of General Systems Theory

- low ambition ... high confidence ... similarities in the theoretical constructions of different disciplines, ... theoretical models having applicability to at least two different fields of study.
- higher ambition ... lower confidence ... “spectrum of theories” -- a system of systems ... function of a gestalt

[Boulding 1956]

Learning as process

Zero learning ... response ... not subject to correction

Learning I is changing ... response by correction of errors within a set of alternatives

Learning II is ... corrective change in set of alternatives or ... change in sequence of experience

Learning III is ... corrective change in the system of sets of alternatives ... pathogenic

Learning IV probably does not occur in any living organism .... Evolutionary process ...

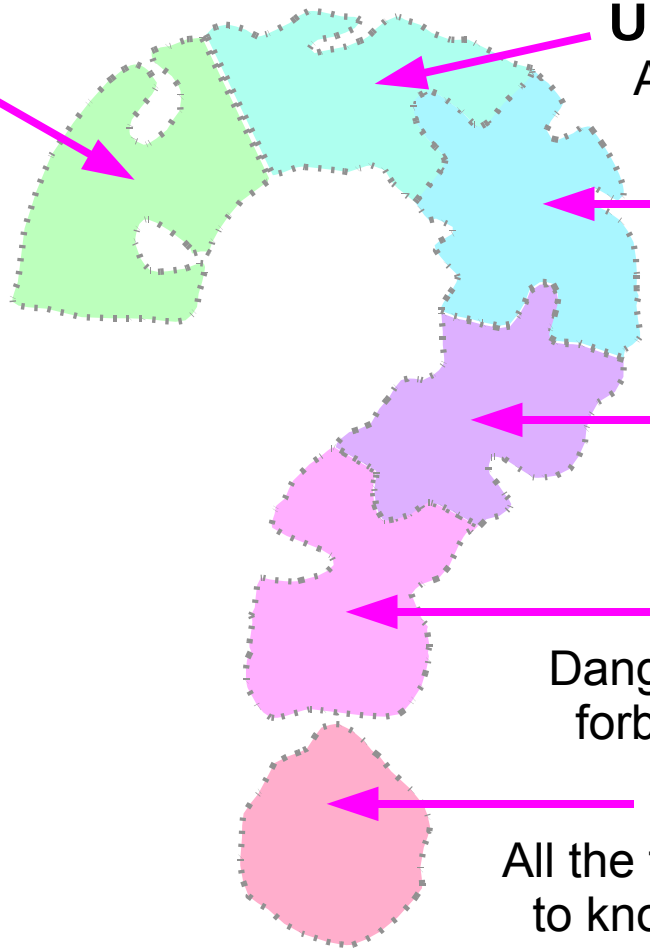
[Bateson 1972]

Map of ignorance

Known Unknowns
All the things you know you don't know

Ignorance Maps
Marlys H. Witte,
Ann Kerwin, and
Charles L. Witte,
The University of Arizona
College of Medicine

"Curriculum on Medical and Other Ignorance: Shifting Paradigms on Learning and Discovery", *Memory Distortions and their Prevention,* Margaret-Jean Intons-Peterson and Deborah L. Best, editors, Lawrence Erlbaum Associates, 1998



Unknown Unknowns
All the things you don't know you don't know

Errors
All the things you think you know but don't

Unknown Knowns
All the things you don't know you know

Taboos
Dangerous, polluting or forbidden knowledge

Denials
All the things too painful to know, so you don't

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1. Challenges
2. Service systems
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2.1 Forms of service systems and challenges

2.2 Coproduction of outcomes, interactive value

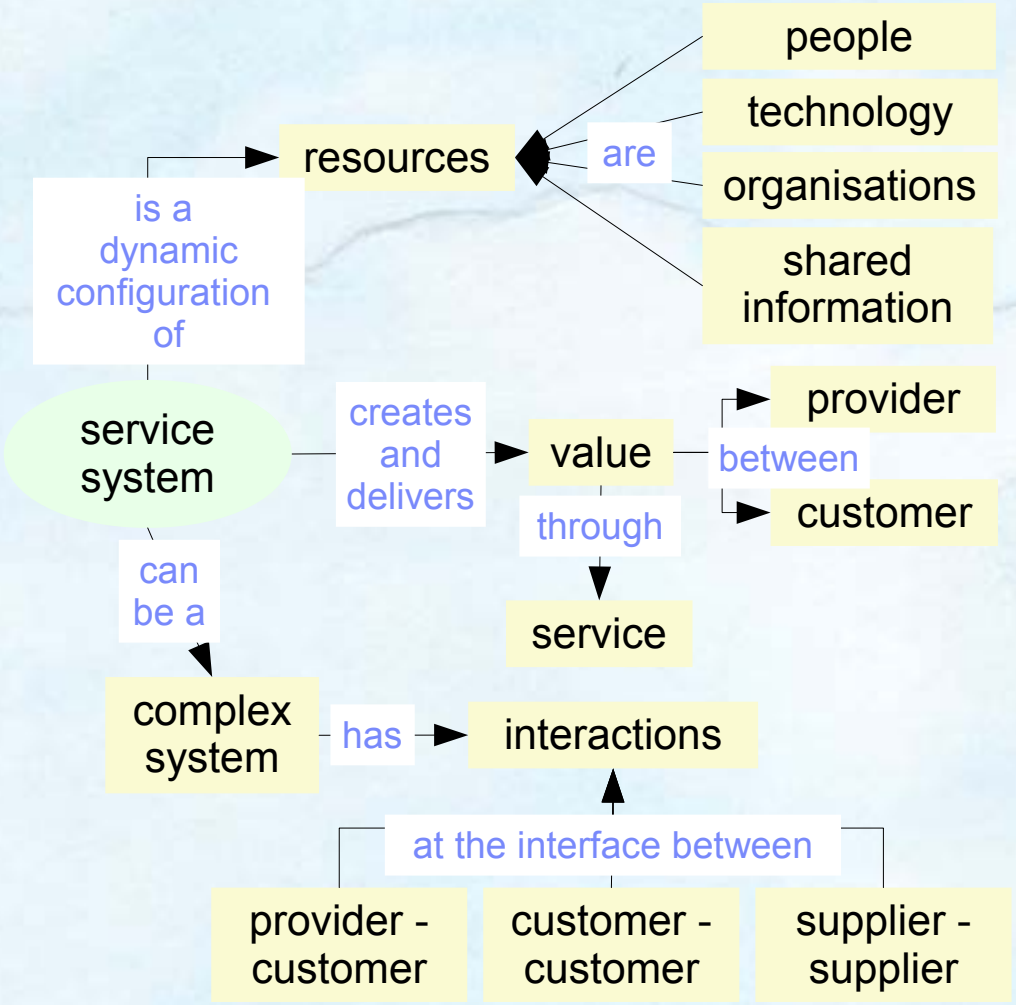
2.3 The unobservable becoming observable

Human civilization is served by systems in technical, organizational and socio-political form

Systems that move, store, harvest, process	•Transportation	K
	•Water and waste management	1
	•Food and global supply chain	2
	•Energy and energy grid	3
	•Information and communications (ICT) infrastructure	4
Systems that enable healthy, wealthy and wise people	•Building and construction	5
	•Banking and finance	6
	•Retail and hospitality	7
	•Healthcare	8
	•Education (including universities)	9
Systems that govern	•Government (cities)	10
	•Government (regions / states)	11
	•Government (nations)	12

[Spohrer and Maglio 2010]

Service systems – a definition



A service system can be defined as a dynamic configuration of resources (people, technology, organisations and shared information) that creates and delivers value between the provider and the customer through service.

In many cases, a service system is a complex system in that configurations of resources interact in a non-linear way. Primary interactions take place at the interface between the provider and the customer. However, with the advent of ICT, customer-to-customer and supplier-to-supplier interactions have also become prevalent. These complex interactions create a system whose behaviour is difficult to explain and predict. (IfM and IBM, 2008, p. 6)

Source: IfM, and IBM. 2008. *Succeeding through Service Innovation: A Service Perspective for Education, Research, Business and Government.* Cambridge, UK: University of Cambridge Institute for Manufacturing. http://www.ifm.eng.cam.ac.uk/ssme/ .

Coproduction of outcomes, interactive value

... producer-product is quite different from ... cause-effect. [....] [The] use of the producer-product relationship requires the environment to explain everything whereas use of cause-effect requires the environment to explain nothing. Science based on the producer-product relationship is environment-full, not environment-free. [Ackoff 1981, p. 21]

2.31. *Coproducers*: two or more objects, properties and/or environments that are producers of the same product.

Since no producer is ever sufficient for its product, every producer has at least one coproducer. The set of all coproducers of a product *y* is the cause of *y*, since the set is sufficient as well as necessary for *y*. [Ackoff and Emery 1972, p. 23]

2.40. *Outcome*: the product of an individual's or system's action.

In other words, the outcome of an individual's or system's action is a change in that individual or system, or its environment, which is produced by that action. [Ackoff and Emery 1972, p. 26]

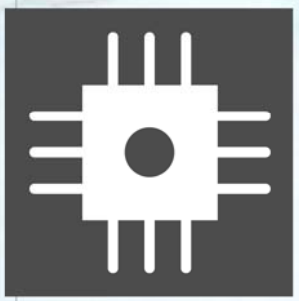
Facilitating *customer value* creation is, within the co-productive point of view, the *raison d'être* for a firm.

This perspective shifts the focus of strategic attention from actor or 'activity' to interaction. [Ramírez and Wallin 2000, p. 47]

How is value produced from the point of view of the customer?

... for customers, value is not 'added' in the interaction between customer and supplier (when the customer buys [a white] shirt), but in the interaction between the customer and the customer's customer or counterpart (when they buyer wears the shirt and her family and others see it on her). [Ramírez and Wallin 2000, p. 43]

The unobservable becoming observable

Pre-digital physical infrastructure	*Converging physical and digital infrastructure*
World as invisible or unobserved	Our world is becoming INSTRUMENTED 
Analog / synchronous connections, person-to-person and machine-to-machine	Our world is becoming INTERCONNECTED 
Things as dumb or unresponsive to interaction	Virtually all things, processes and ways of working are becoming INTELLIGENT 

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3.1 Resilience

3.2 Cross-scale relations and panarchy

3.3 Regime shifts and thresholds

Resilience

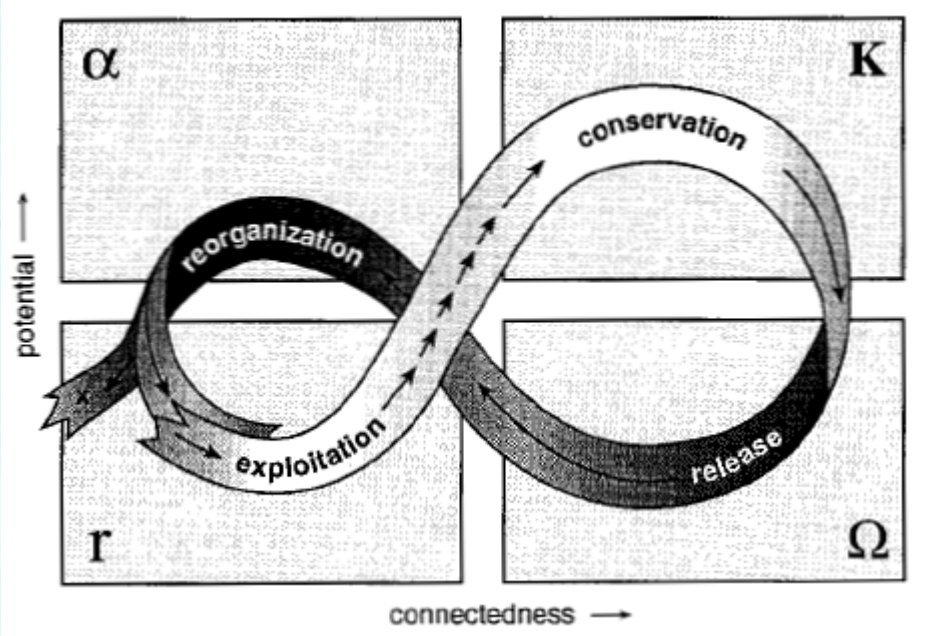


Figure 4. A stylized representation of the four ecosystem functions (r, K, Ω, α) and the flow of events among them.

[Holling 2001]

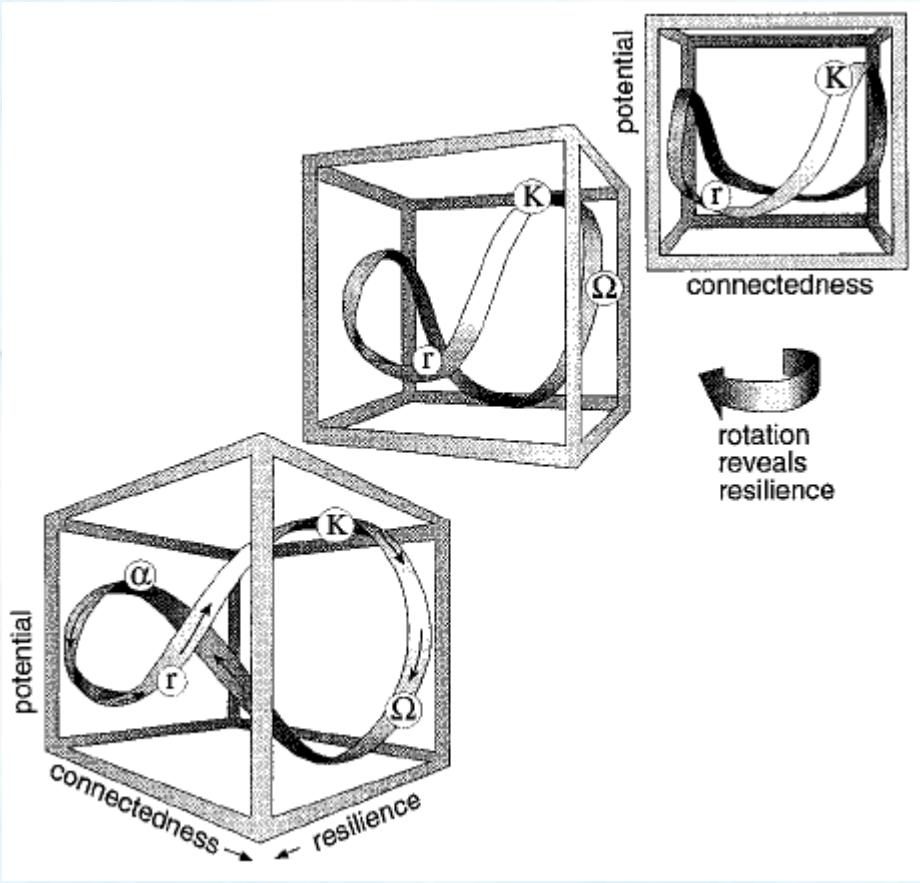


Figure 5. Resilience is another dimension of the adaptive cycle.

Cross-scale relations and panarchy

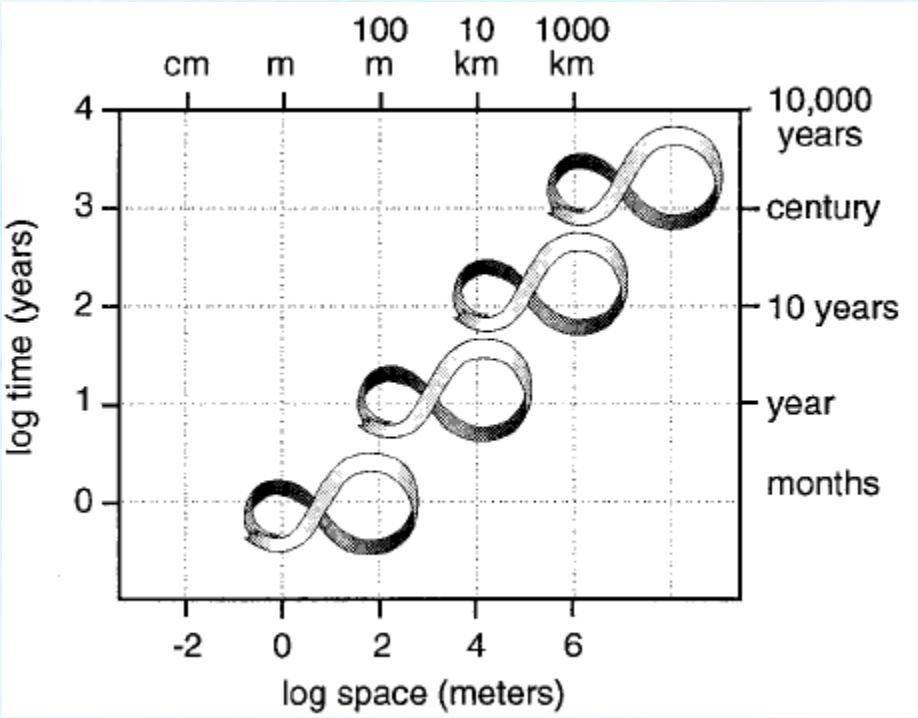


Figure 6. A stylized panarchy. A panarchy is a cross scale, nested set of adaptive cycles that indicates the dynamic nature of structures depicted in the previous plots.

[Holling 2001]

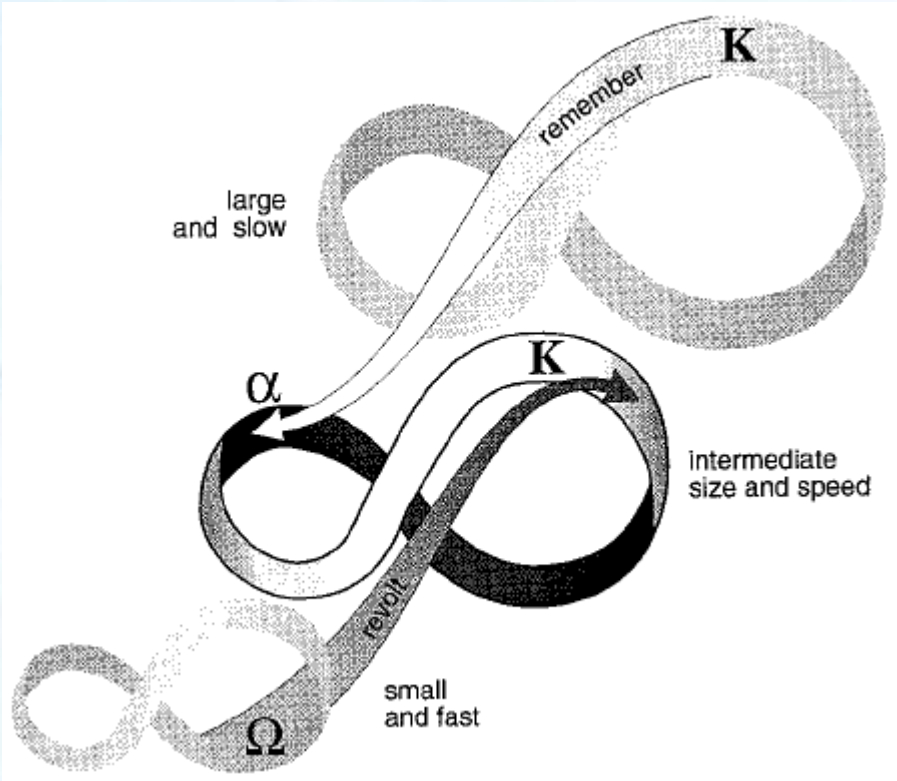
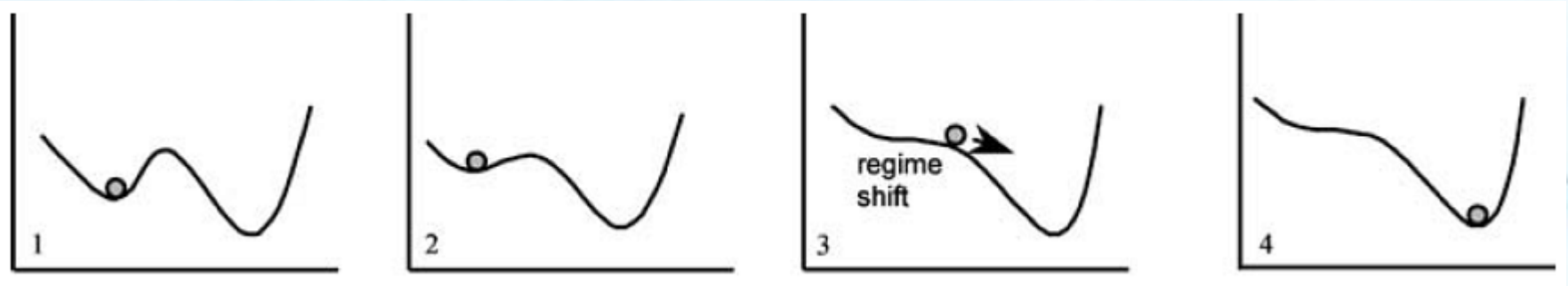


Figure 7. Panarchical connections. [....] the "revolt" connection ...can cause a critical change in one cycle to cascade up to a vulnerable stage in a larger and slower one. The ... "remember" connection ... facilitates renewal by drawing on the potential that has been accumulated and stored in a larger, slower cycle.

Regime shifts and thresholds



clear-water lakes	phosphorous accumulation in agricultural soil and lake mud	flooding, warming, overexploitation of predators	turbid-water lakes
coral-dominated reefs	overfishing, coastal eutrophication	disease, bleaching hurricane	algae-dominated reefs
grasslands	fire prevention	good rains, continuous heavy grazing	shrub-bushland
grassland	hunting of herbivores	disease	woodland
...	...	...	...

Figure 2 Alternate states in a diversity of ecosystems (1, 4) and the causes (2) and triggers (3) behind loss of resilience and regime shifts.

[Folke, Carpenter, Walker, Scheffer, Elmqvist, Gunderson and Holling 2004]

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4.1. Socio-psychological, socio-technical, socio-ecological systems
4.2. Collapse, resilience, sustainability, regeneration
4.3. Complicatedness, complexity, gain
4.4. Dialogue, conversation, language-action
4.5. Power laws, scale-free networks
4.6. Communities of practice, world disclosing
4.7. Open standards, open source, reference models

Socio-psychological, socio-technical, socio-ecological systems

[... the] socio-psychological, the socio-technical and the socio-ecological perspectives ... emerged from each other in relation to changes taking place in the wider social environment. One could not have been forecast from the others. Though interdependent, each has its own focus. Many of the more complex projects require all three perspectives. [Trist & Murray 1997, p. 30]

Socio-psychological

... in Institute projects, the psychological forces are are directed towards the social field, whereas in the the Clinic, it is the other way around [with social forces directed toward the psychological field].

[Trist & Murray 1997, p. 31]

Social-technical

... the best match between the social and technical systems of an organization, since called the principle of joint optimization

... the second design principle, the redundancy of functions, as contrasted with the redundancy of parts.

[Trist & Murray 1997, p. 32]

Socio-ecological

... the context of the increasing levels of interdependence, complexity and uncertainty that characterize societies a the present time.

... new problems related to emergent values such as cooperation and nurturance.

[Trist & Murray 1997, p. 33]

Collapse, resilience, sustainability, regeneration

Collapse

A society has collapsed when it displays a rapid, significant loss of an established level of sociopolitical complexity. [....]

Losses that are less severe, or take longer to occur, are to be considered cases of weakness and decline.

[Tainter 1990]

Resilience

[Engineering resilience means] stability near an equilibrium steady state, ... resistance to disturbance and speed of return to the equilibrium are used to measure the property. [...]

[Ecological resilience means] conditions far from any equilibrium steady state, ... instabilities can flip a system into another regime of behavior ... to another stability domain

[Holling 1996]

Sustainability

"Of what, for whom, for how long, and at what cost?" ... sustainability as maintaining, or fostering the development of systemic contexts that produce the goods, services and amenities that people need or value, at an acceptable cost, for as long as they are needed or valued.

[Allen, Tainter and Hoekstra 2003]

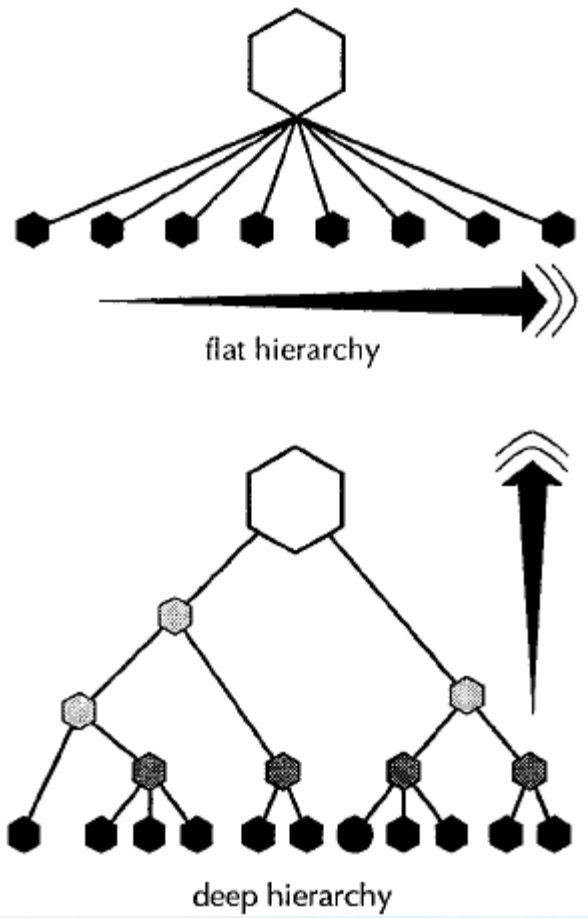
Regeneration

... regenerative systems tend to follow a strategy of dispersal, or spreading out over the landscape, combined with some degree of augmentation. [....]

Whatever the means used, sustainability requires that the basic processes not be exploited beyond their capacity for renewal.

[Lyle 1996]

Complicatedness, complexity, gain



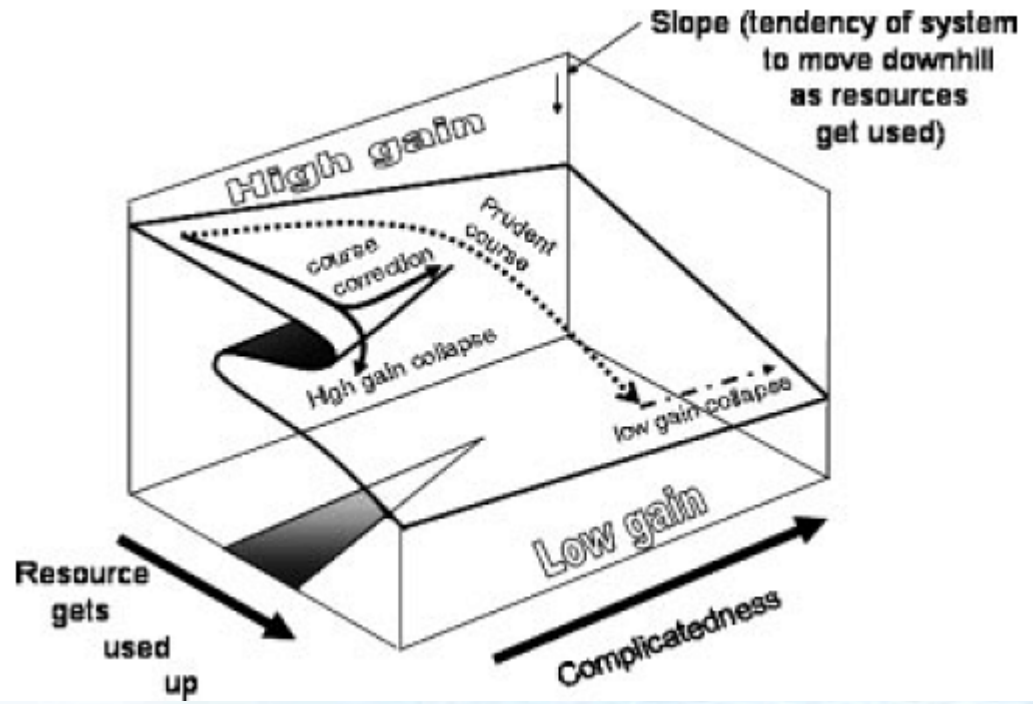


Figure 7. A representation of the tracks that lead from high to low to super low gain patterns. [Allen, Allen, Malek 2006]

Figure 3. The top hierarchy shows increases in complicatedness by increasing the structural elaboration. Structural elaboration is portrayed as widening the span in horizontal differentiation. The bottom hierarchy shows increasing complexity, by an elaboration of organization. New levels appear as new constraints emerge as limits to the positive feedbacks of the emergent process. Elaboration or organization increases hierarchical depth. [Allen, Tainter, Hoekstra 1999]

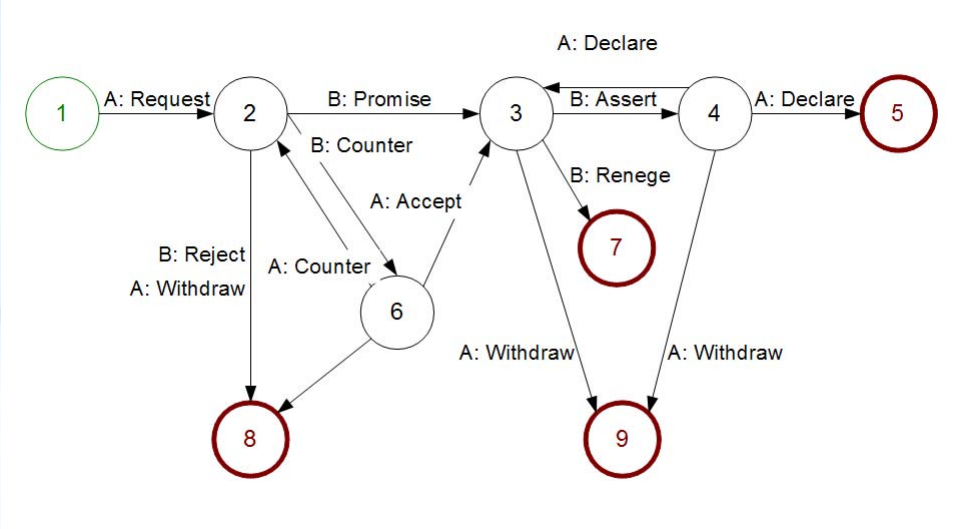
Dialogue, language-action, conversation

Dialogue

The type of dialogue discuss heretofore is often called "generative," meaning that it generates a collective worldview.

... ... strategic dialogue focuses on specific issues and tasks and is applied in finding specific solutions in organizational and social systems settings.

[Banathy 1996, p. 28]

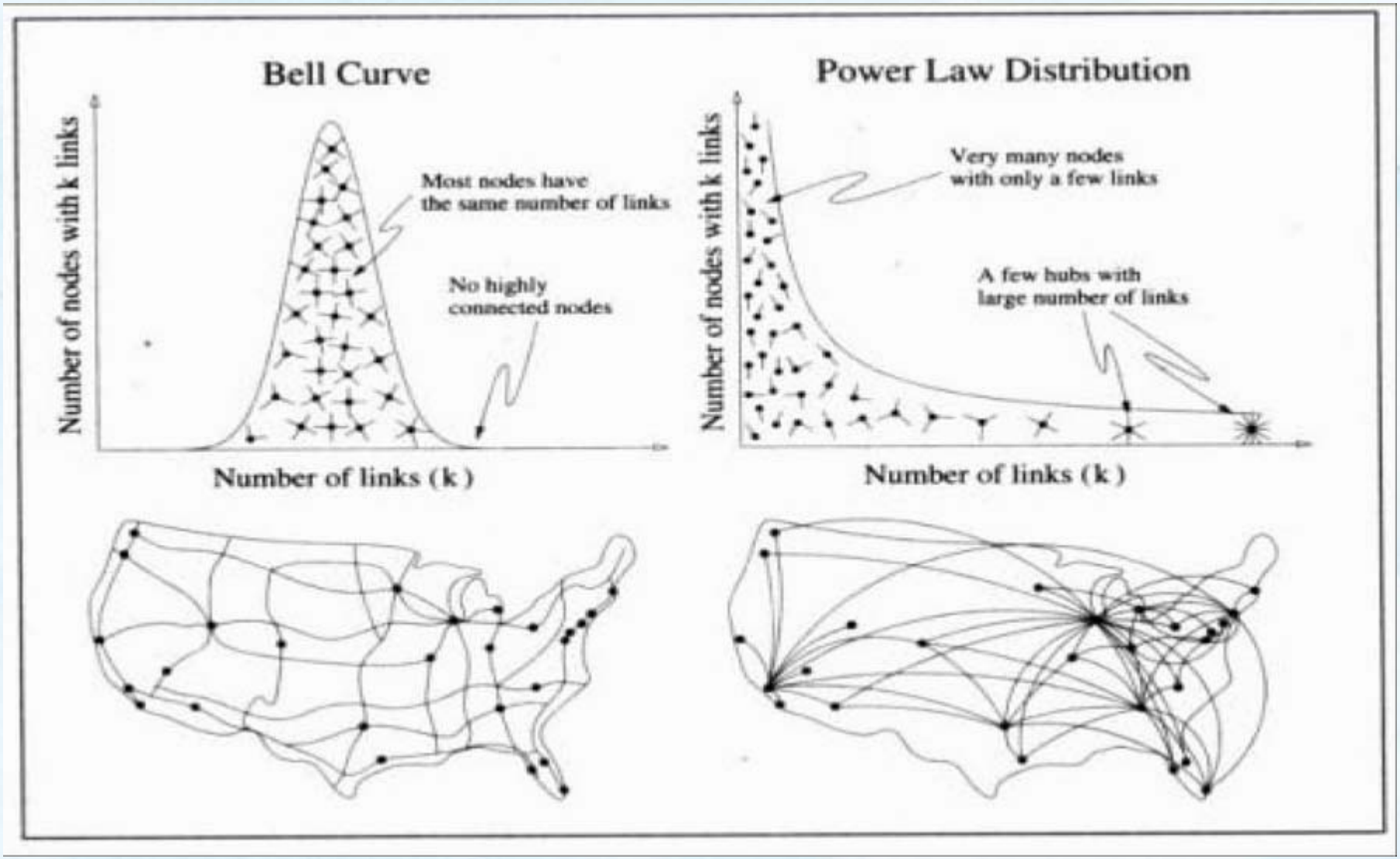


The basic conversation for action
[Winograd and Flores, 1986]

We distinguish several additional kinds of conversation that go along with conversations for action (CfA):

- conversation for clarification,
- conversation for possibilities, and
- conversation for orientation. [Winograd 1986]

Power laws, scale-free networks



[Barabasi 2002]

Communities of practice, world disclosing

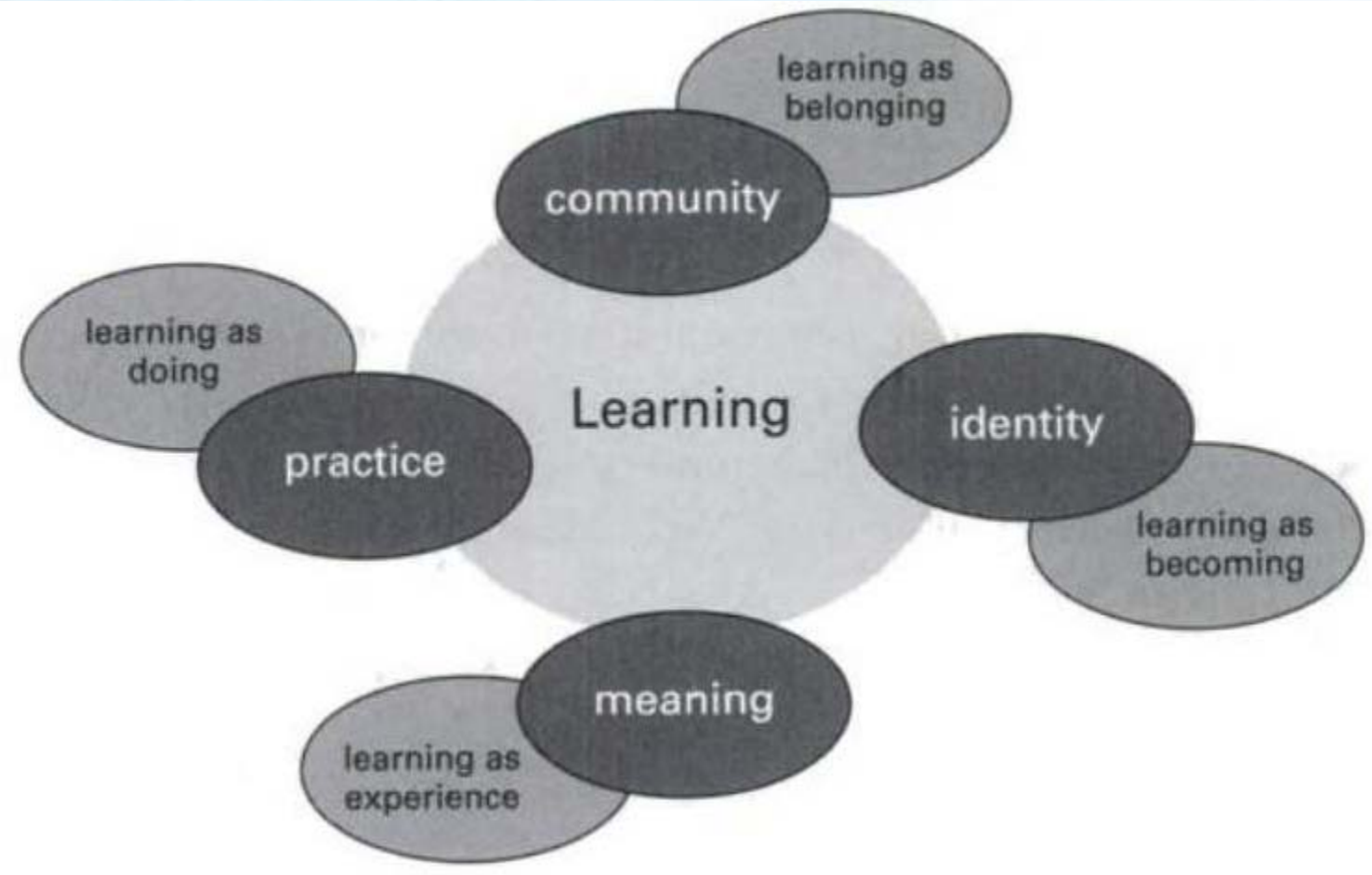
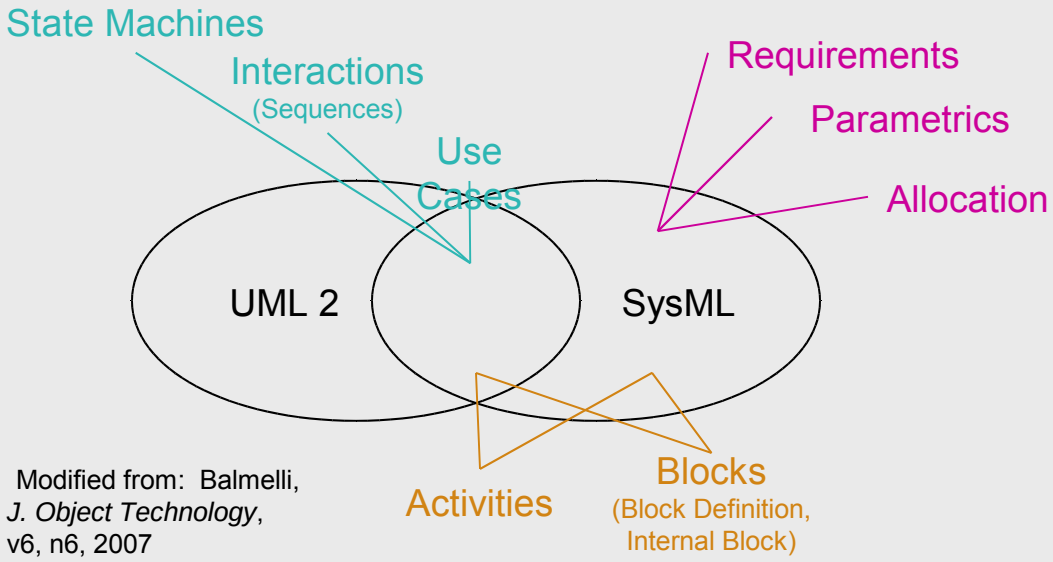


Figure 0.1. Components of a social theory of learning: an initial inventory

[Wenger 1998]

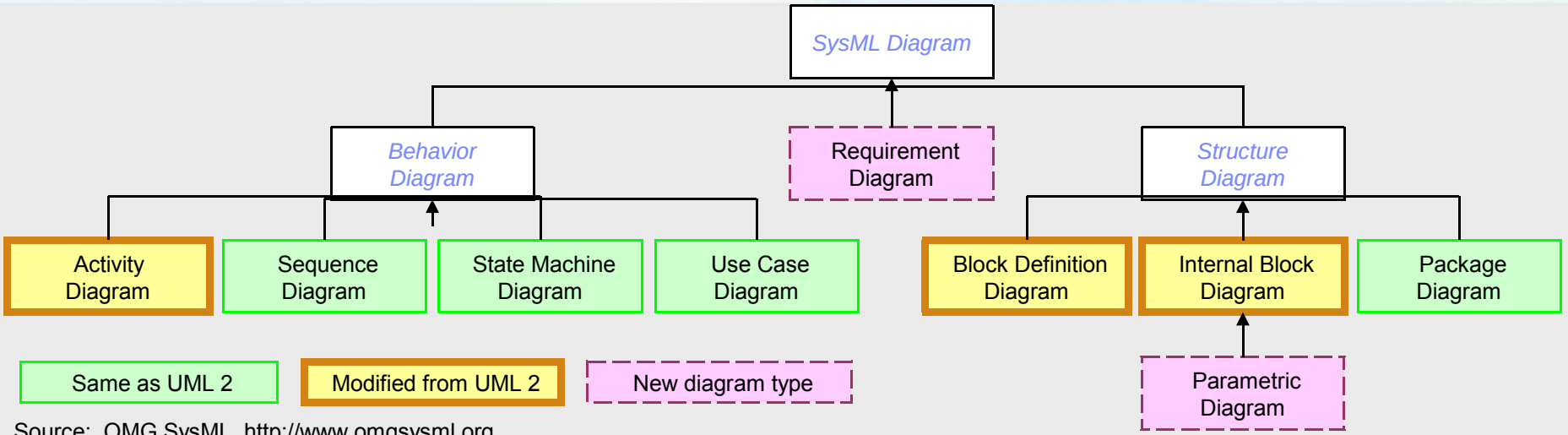
Open standards, open source, reference models

OMG directors adopted SysML 1.1, October 15, 2008



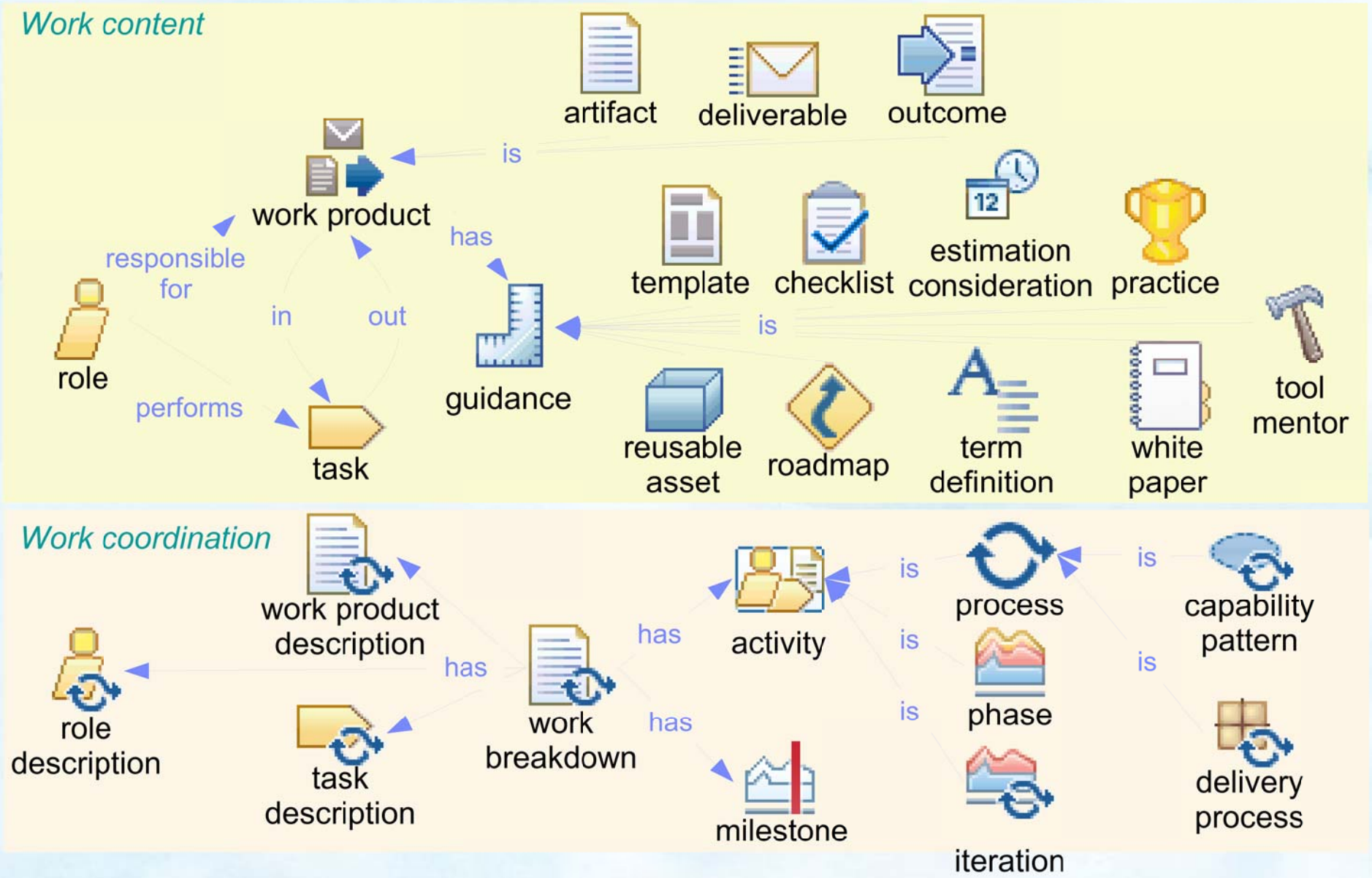
Modified from: Balmelli, *J. Object Technology*, v6, n6, 2007

SysML	*UML analog*
Activity diagram	Activity diagram
Block Definition diagram	Class diagram
Internal Block diagram	Composite structure diagram
Package diagram	Package diagram
Parametric diagram	N/A
Requirement diagram	N/A
State Machine diagram	State Machine diagram
Sequence diagram	Sequence diagram
Use Case diagram	Use Case diagram
Allocation tables	N/A
N/A	Component diagram; Communication diagram; Deployment diagram; Interaction overview diagram; Object diagram Timing diagram

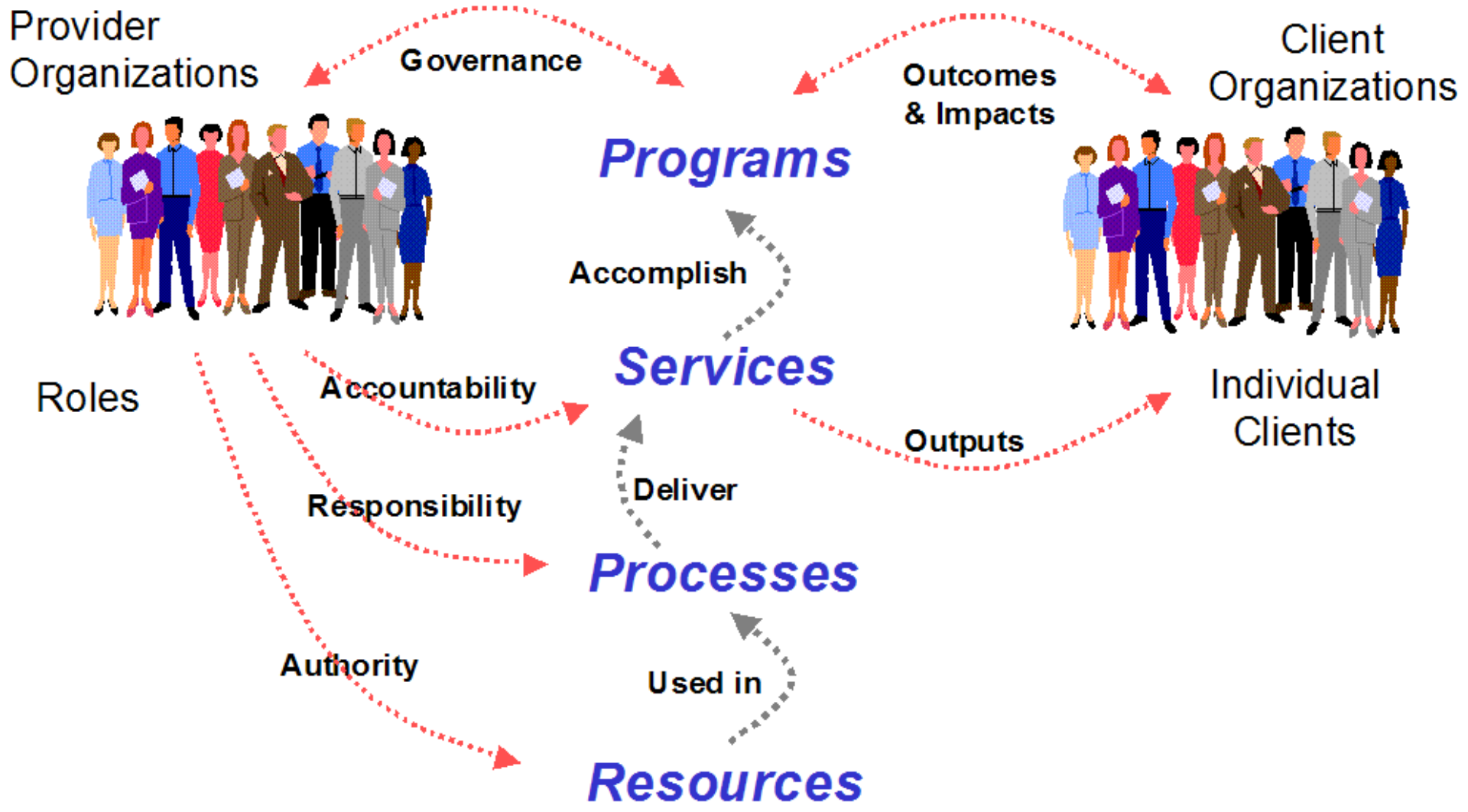


Source: OMG SysML, http://www.omgsysml.org

Open Unified Process – Methods Content and Process Content



Program and Services Reference Model, Government of Ontario



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How can ISSS 2012 be structured to encourage learning?

The systems approach begins
when you first see the world
through the eyes of another.

C. West Churchman, *The Systems Approach*, 1968.

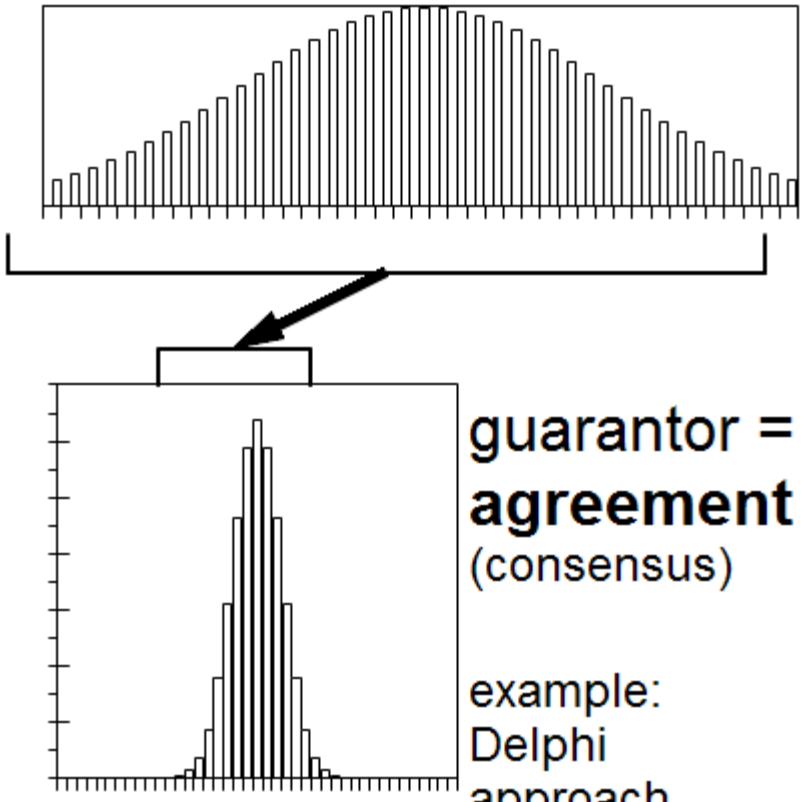
An Inquiry System, or IS for short,
is a system of interrelated components
for producing knowledge
on a problem or issue of importance

Ian Mitroff and Harold Linstone, *The Unbounded Mind*, 1968.

Ways of knowing (1, 2)

The first way of knowing

Inductive-Consensual IS

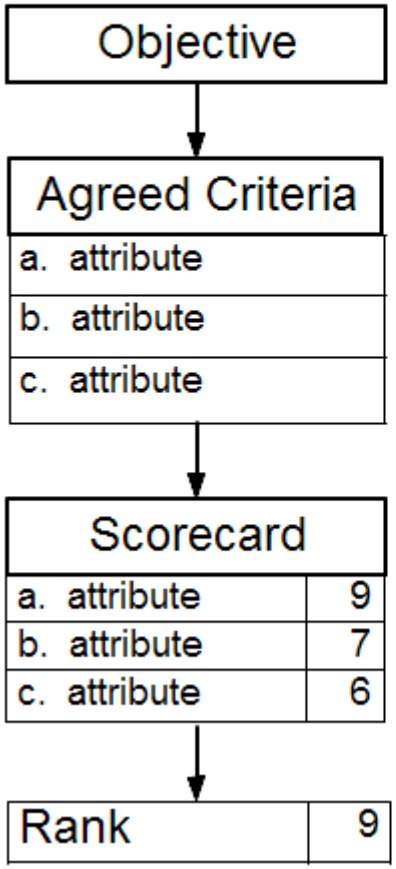


guarantor = **agreement** (consensus)

example: Delphi approach

The second way of knowing

Analytic-Deductive IS



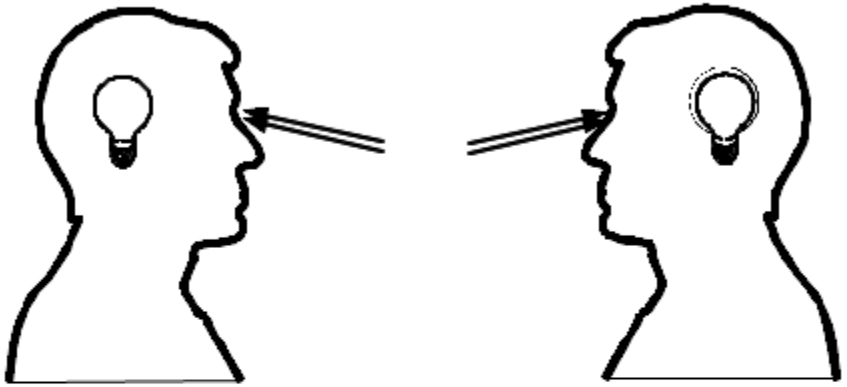
guarantor = **logical consistency** (fact nets)

example: finding the "best man" for the job

Ways of knowing (3, 4)

The third way of knowing

Multiple Realities IS



model + data as inseparable whole

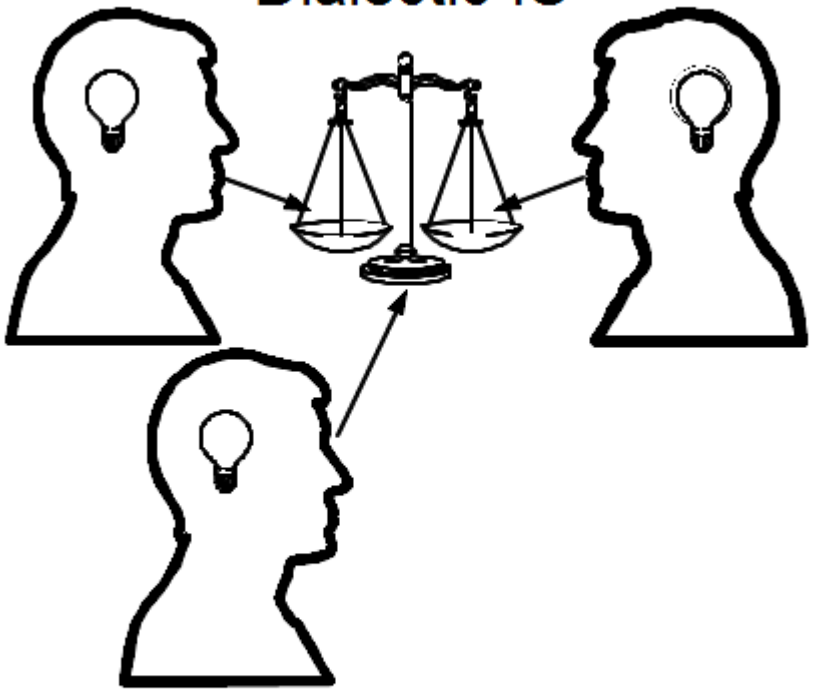
For human beings to have experience or gain knowledge about the external world, something must be built into the internal structure of their minds ...

guarantor = (ability to see) range of views (representations)

example: disciplinary views of the causes of the drug problem

The fourth way of knowing

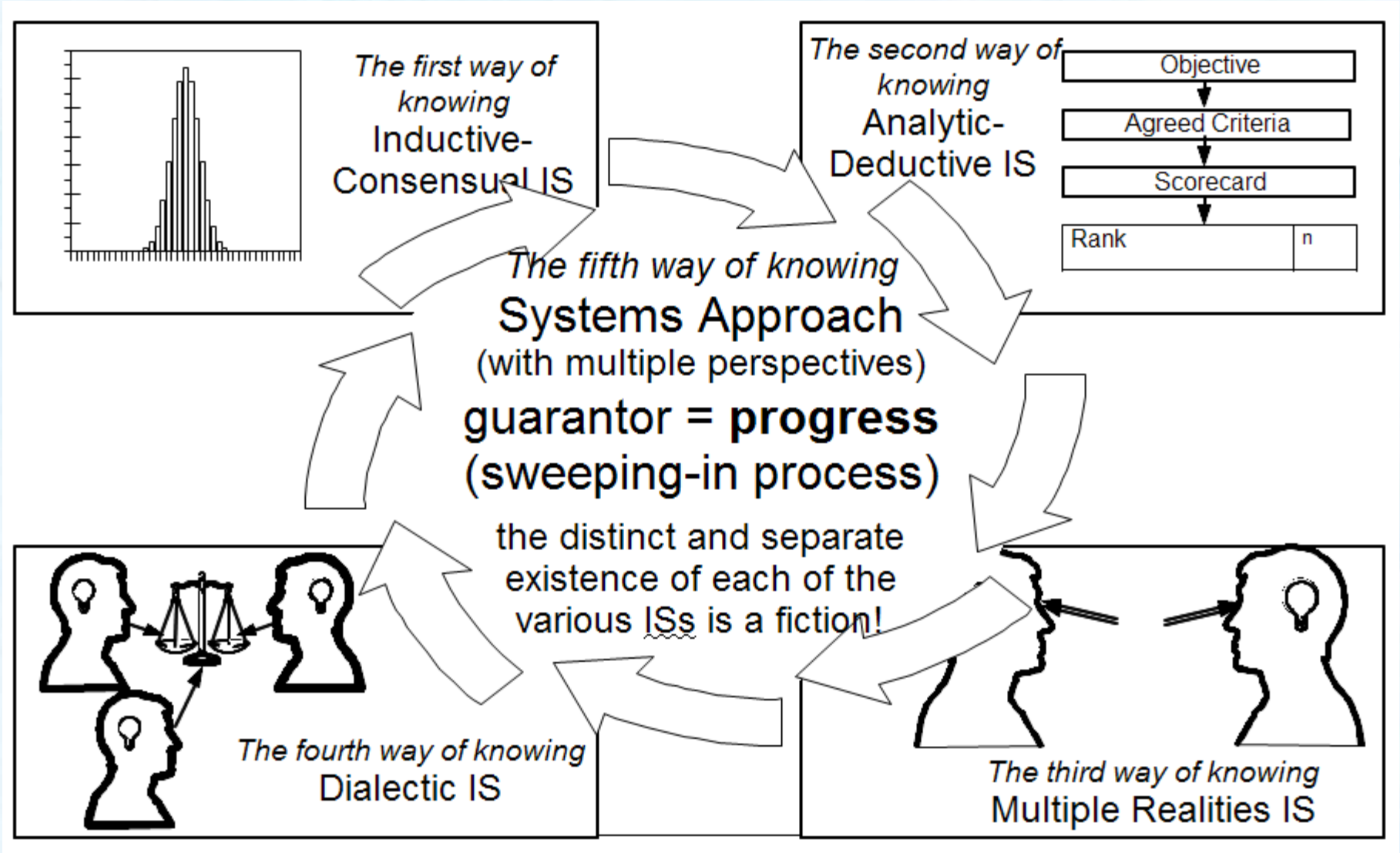
Dialectic IS



guarantor = conflict

example: challenging assumptions of what skid row housing should be

Ways of knowing (5)



A call for participation in San Jose, CA USA, July 15-20, 2012

The systems sciences provide a platform of concepts and language that enables communities of interest to transcend disciplinary boundaries towards developing new knowledge and perspectives. The *ISSS 2012* theme of *Service Systems, Natural Systems* draws attention to complex issues in today's world, where dialogue amongst the learned may lead to better futures.

The *service systems* sciences focus on the value cooperatively created and shared in human activities. Service systems support basic needs such as food and water, develop social potential through education and healthcare, and advance our societies through businesses, governments and social enterprises working in a globalized, networked world.

The *natural systems* sciences focus on the sustainability and diversity of life on our planet. Social ecological systems balance competing interests of human well-being, social development and economic progress. Maintaining resilience of natural capital and resources across temporal and spatial scales challenges policies, governance and stewardship.

The sessions of ISSS 2012 will foster learning conversations. The dialectic between service scientists and natural scientists will sweep in new perspectives in dialogues beyond disciplinary boundaries.

This meeting is designed at an interactive and collegial scale of 100 to 250 thinkers with diverse backgrounds and interests in the arts and sciences of systems.

Ways to participate include:

- Engaging with plenary speakers, discussants and groups in reflections
- Leading conversations on research in progress and early findings
- Presenting pre-published works for commentary and refinement
- Sharing experiences and knowledge sketched onto posters and outlines
- Building personal insights in diverse dialogues about systems

Quickpaths

- About the ISSS
- Join ISSS
- San Jose 2012
  - Presidential Address 2012
- Hull 2011
  - Important Dates
  - Registration
  - Program Outline
  - Workshops Detail
  - Accommodation
  - Traveling to Hull
  - Preparing and Submitting Abstracts and Papers
  - Plenaries
  - SIG Contacts
  - Sir Geoffrey Vickers' Award for Best Student Paper
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